depositing a silicon containing photoresist layer on top of the amorphous carbon layer;

developing a pattern transferred into the resist layer with a photolithographic process;

etching through the amorphous carbon layer in at least one region defined by the pattern in the resist layer; and

forming an in situ resist layer hard mask in an outer portion of the photoresist layer.

2. The method of claim 1, wherein depositing the amorphous carbon layer comprises forming the layer with a chemical vapor deposition process.

3. The method of claim 1, wherein depositing the silicon containing photoresist layer comprises forming the layer with a spin on deposition process.

4. The method of claim 1, wherein etching through the amorphous carbon layer comprises exposing the amorphous carbon layer to an oxygen based etchant.

5. The method of claim 4, wherein the oxygen based etchant chemically reacts with silicon in the silicon containing photoresist layer to form the resist layer hard mask.

6. The method of claim 5, wherein the resist layer hard mask has a thickness of less than about 1000 Å.

7. The method of claim 5, wherein the resist layer hard mask has a thickness of between about 50Å and about 1000 Å.

8. The method of claim 5, wherein the resist layer hard mask has a thickness of between about 75 Å and about 250 Å.

9. The method of claim 5, wherein the resist layer hard mask has a thickness of between about 100 Å and about 200 Å.

10. The method of claim 1, further comprising forming a material layer on the substrate with a chemical vapor deposition process prior to forming the amorphous carbon layer.

11. The method of claim 10, wherein the material layer comprises at least one of silicon dioxide and silicon nitride.

12. The method of claim 1, wherein the silicon containing photoresist layer comprises between about 3% to about 30% silicon.

13. The method of claim 1, wherein the silicon containing photoresist layer comprises between about 3% to about 10% silicon.

14. The method of claim 1, wherein the silicon containing photoresist layer comprises between about 5% to about 7% silicon.

15. The method of claim 1, wherein the silicon containing photoresist layer, the amorphous carbon layer, and the resist layer hard mask may be removed by a single etching process selective to these layers and leaving an underlying layer on the substrate.

16. The method of claim 1, wherein the resist layer hard mask is formed during the etching process.

17. A method for patterning a material layer in a multilayer stack, comprising:

depositing an amorphous carbon layer on the material layer;

depositing a photoresist layer on top of the amorphous carbon layer;

developing a resist pattern transferred into the photoresist layer;

etching through the amorphous carbon layer in a patterned region defined by the resist pattern;

forming an in situ resist layer hard mask in an outer portion of the photoresist layer during the etching process for the amorphous carbon layer; and

etching through the material layer under the amorphous carbon layer using the patterned region etched into the amorphous carbon layer and the resist pattern.

18. The method of claim 17, wherein the steps of etching through the amorphous carbon layer and forming the resist layer hard mask are cooperatively conducted in a single chemical process.

19. The method of claim 17, wherein forming the photoresist layer further comprises forming the photoresist layer having a predetermined quantity of silicon therein.

20. The method of claim 19, wherein forming the resist layer hard mask further comprises chemically reacting the predetermined quantity of silicon with an oxygen based etchant used to etch the amorphous carbon layer.

21. The method of claim 17, wherein the amorphous carbon layer and the material layer are deposited using a chemical vapor deposition process.

22. The method of claim 17, wherein depositing the photoresist layer comprises using a spin-on deposition process.

23. The method of claim 17, wherein developing the resist pattern comprises utilizing a photolithographic development process.

24. The method of claim 17, wherein etching through the amorphous carbon layer comprises applying an oxygen based etchant to the multilayer stack.

25. The method of claim 17, wherein forming the resist layer hard mask further comprises reacting silicon in the photoresist layer with an oxygen based etchant used to etch the amorphous carbon layer to form a silicon oxide layer in outer portions of the photoresist layer.

26. The method of claim 17, wherein the resist layer hard mask has a thickness of less than about 1000 Å.

27. The method of claim 17, wherein the resist layer hard mask has a thickness of between about 75 Å and about 250 Å.

28. The method of claim 17, wherein the resist layer hard mask has a thickness of between about 100 Å and about 200 Å.

29. The method of claim 17, further comprising removing the resist layer hard mask, the photoresist layer, and the amorphous carbon layer to expose a desired pattern in the material layer.

30. The method of claim 17, wherein forming the resist layer hard mask comprises reacting a first substance in the photoresist layer with a second substance in a chemical etchant to form the resist layer hard mask in an outer portion of the photoresist layer.

31. The method of claim 30, wherein the first substance comprises silicon.

32. The method of claim 30, wherein the second substance comprises oxygen.

33. The method of claim 19, wherein the predetermined quantity of silicon is between about 3% and about 30% silicon.

34. The method of claim 19, wherein the predetermined quantity of silicon is between about 3% and about 10% silicon.

35. The method of claim 19, wherein the predetermined quantity of silicon is between about 5% and about 7% silicon.

36. A method for forming a hardmask in a resist layer, comprising:

depositing a silicon containing photo resist layer over a material layer;

developing a pattern in the silicon containing photo resist layer;

etching the material layer with an oxygen based etchant to transfer the pattern into the material layer; and

forming a hardmask layer in the silicon containing photo resist layer during the etching process.

37. The method of claim 36, wherein forming a hardmask later in the silicon containing photo resist layer comprises chemically reacting silicon in the resist layer

with the oxygen based etchant to form a hardmask silicon dioxide layer in an outer portion of the resist layer.

38. The method of claim 36, wherein the silicon containing photo resist layer contains between about 3% and about 30% silicon.

39. The method of claim 36, wherein the silicon containing photo resist layer contains between about 3% and about 30% silicon.

40. The method of claim 36, wherein the silicon containing photo resist layer contains between about 5% and about 1% silicon.

41. The method of claim 36, wherein the silicon containing photo resist layer contains between about 5% and about 7% silicon.

42. The method of claim 36, wherein the hardmask layer has a thickness of less than about 1000 Å.

43. The method of claim 36, wherein the hardmask layer has a thickness of between about 75 Å and about 250 Å.

44. The method of claim 36, wherein the hardmask layer has a thickness of between about 100 Å and about 200 Å.

REMARKS

This is intended as a full, complete, and timely response to the Office Action dated October 24, 2001, having a shortened statutory period for response set to expire on January 24, 2002. Claims 1 – 44 were rejected by the Examiner, are unamended in this response, and therefore, remain pending.

Claims 1 – 7 and 36 – 42 stand rejected under 35 U.S.C. §103(a) as being unpatentable over *Babich* (U.S. Patent No. 5,830,332) in view of *Lin* (U.S. Patent No. 6,087,064). The Examiner takes the position that *Babich* generally teaches the deposition of an amorphous carbon layer for use as a hard mask to etch an underlying metal layer. Further, the Examiner takes the position that *Lin* teaches the use of a